The Geophysical Fluid Dynamics Summer Study Program

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LONG-TERM GOAL

The long-term goal is to train new scientists to conduct research, and to enhance the abilities of experienced research workers in geophysical fluid dynamics.

OBJECTIVES

To help graduate students formulate and tackle innovative research problems in GFD. To promote an exchange of knowledge and ideas between investigators in the different scientific disciplines that deal with the dynamics of stratified and rotating fluids. To formulate tractible, important problems which are presently at the fringe of our understanding in the field of Geophysical Fluid Dynamics. To serve as a clearing house for the mathematical, experimental and computational techniques which serve astrophysics, climate science, geodynamics, meteorology and oceanography.

APPROACH

We conduct a summer study school of ten weeks duration each summer. The participants are graduate student fellows, visiting graduate students and visiting scientists. The first two weeks consist of principal lectures in the summer's topic conducted by an expert in that area. Lectures by associated participants follow at a rate of roughly one or two per day for the remaining weeks except for the last week, when student fellows present their results. Approximately ten graduate students are admitted as Fellows. Each Fellow receives a stipend for the full ten weeks, conducts a research project under the guidance of the staff and provides a written project report. The fellows also write up the principal lectures. Several other graduate students visit for shorter periods to listen to lectures and interact with the staff. The staff (i.e. all of the visiting scientists) is continually renewed by inviting new participants from the various disciplines with an interest in rotating, stratified fluid flows. Most of these participants receive partial support from the program. Continuity is provided by a small group of participants who attend regularly (once every two years or more frequently). Little direct support is provided to this latter group. The lecture notes and the written report of the fellows' projects are contained in a volume which will be distributed in print form and put on the Web. (The web version will be available at www.whoi.edu/gfd/ in December, 1998 – our ongoing construction efforts may be viewed at gfd20.whoi.edu/~gfdvol /src/Book.html).

ACCOMPLISHMENTS

A popular and productive 1998 supper program was organized by Dr. Neil Balmforth (U. C. Santa Cruz from January 1999), who wrote in the volume preface ``Astrophysical and geophysical flows as dynamical systems was the theme of the 1998 GFD Summer Program. With Antonello Provenzale at

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the helm we sailed headlong into the nonlinear world of astrophysical and geophysical fluid mechanics. Simultaneously, Charles Tresser gave several energetic presentations surrounding the dynamics of circle maps.

Unfortunately our third planned speaker, John David Crawford, fell ill just prior to the program and could not participate. Sadly, John David passed away later in the summer. We will remember him at GFD from the excellent lectures he gave at the cottage during the summer of 1993.

In a departure from usual practice, and in an effort to lend more coherence to the, at times, very wide ranging topics discussed at Walsh, GFD98 included three "theme weeks." The first, championed by Steve Meacham, organized a week-long series of lectures on climate dynamics. Alastair Rucklidge subsequently gathered together several experts on bifurcation and pattern theory. Lastly, Diego del Castillo-Negrete organized the ``Mixing Week." These themes, and especially the third, proved so popular that we doubled the total number of visitors to the program.

In tandem to the extensive seminar schedule, the fellows progressed significantly in their projects; their reports reflect the impressive progress made."

The Fellows for 1998 are:

Aaron C. Birch Stanford University
Sarah L. Dance Brown University
Blanca Gallego University of California at Los Angeles
Andrew R. Jacobson Pennsylvania State University
Panayotis Kevrekidis Rutgers University
Andrew E. Kiss Australian National University, AUSTRALIA
Carolyn R. Mockett Scripps Inst. of Oceanography, Univ. of Calif. at San Diego
Claudia Pasquero Istituto di Cosmogeofisica, Torino, ITALY
Mark S. Roulston California Institute of Technology
Amy Qing Shen University of Illinois at Urbana-Champaign

SCIENTIFIC/TECHNICAL RESULTS

The principal lectures and fellows' reports are the tangible results. TABLE I lists the principal lecture titles

Principal Lectures

By Ed Spiegel, Columbia University:

Introduction

By Antonello Provenzale. Istituto di Cosmogeofisica, Torino, Italy:
Introduction to Dynamical Systems With the Example of a Dust Grain in a Stratified Atmosphere (tutorial)

Energy Balance Models, the Lorenz 63 Model (derivation), the Lorenz 84 Model for the Atmosphere

Time Series Analysis and Phase-Space, Reconstruction: The Example of the light

Curve of 3C
345 Driving of
Driving Chaotic Systems: Seasonal Forcing in Lorenz 84, Stochastic Thermohaline Box Model, Stochastic Resonance
Coupling Chaotic Systems II: Analysis of Coupled Lorenz 84 Models, Chaotic Resonance -Synchronization and On-Off Desynchronization
Extended Systems, Coherent Vortices, The Vortices of 2D Turbulence, and Coherent Flux Tubes in 2D-MHD
Point Vortices, Chaotic Advection in 2D Flows
Dynamics of Dust Grains in 2D Flows: A Scenario for the Formation of Planetesimals Vortices on Keplerian Disks
Density Singularities in Self-Gravitating Systems

(With Spiegel):
Coupling Chaotic Systems I: On-Off Intermittency (including the PST model for the solar dynamo)

(with Leonard Smith, University of Oxford, UK):
Predictability and Prediction in Dynamical Systems, Predictability of Coupled Systems, Prediction Methods

By Charles Tresser IBM - T.J. Watson Research Labs:
Transition to Chaos, Part I
Transition to Chaos, Part II
Transition to Chaos, Part III
Transition to Chaos, Part IV

TABLE I. Titles of Principal lectures

IMPACT FOR SCIENCE OR SYSTEMS APPLICATIONS

The experiences of the fellows and the staff are difficult to quantify. Many express their enthusiasm at the end of each summer.

TRANSITIONS

We estimate that typically 20-50% of the student projects become included in their thesis or postdoctoral work and/or result in publications. The program does not follow the fellows' research after the summer is finished although individual staff members often remain involved with the fellows' continuation of their projects past the end of the summer. We will be conducting a survey of the last 20 year's fellows soon to more clearly determine the results of the program.

RELATED PROJECTS

All staff members are active research workers, so numerous related projects exist.